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VOLGA RIVER HYDRAULIC DEVELOPMENTS

M. B. Vol'f

During an average year the flow of the Volga River at Stalingrad exceeds 250 cubic kilometers and the Volga is capable of producing 32 billion kilowatt-hours of electricity. The altitude at Kalinin is 124 meters above sea level and at Stalingrad, 11 meters below sea level, thus resulting into a total drop of 135 meters (in addition there is a 15-meter drop below Stalingrad to Astrakhan, which is difficult to utilize, and the drop from the source to Kalinin, which is not being considered for utilization at present).

Three dams with hydroelectric power plants at Ivan'kovo, Uglich, and Shcherbakov have already been built on the Volga, while three additional dams at Gor'kiy, Kuybyshev, and Stalingrad are now under construction.

A series of similar dams is to be built for the utilization of the Volga. The first of these dams is now under construction at Molotov on the Kama River below the mouth of the Chusovaya River. The construction of these hydraulic developments on the Volga and its tributaries will proceed in general downstream, although there may be some deviations from this order.

For complete utilization of the Volga drop, the head created by each dam should extend to the next dam upstream, to the extent that this can be done without flooding important cities and valuable mineral deposits. Also the flooding of large agricultural and forested areas and rural settlements by reservoirs, which are necessary for regulating the flow of the Volga, should be limited. Extremely large reservoirs at and above the mouth of the Kama would exert an undesirable local influence on the climate. Also, very large reservoirs, especially in the south, would greatly increase loss of water through evaporation.

As is shown on the appended longitudinal diagram of the Volga, the head of water created by the Stalingrad dam will extend only approximately to Balakovo, and not to Kuybyshev. This will avoid flooding the oil deposits in the vicinity of the Samara Bend and the sections of Kuybyshev which lie along the river.

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In the future it would be possible to construct another intermediate dam here. The Kuybyshev dam is being built above Kuybyshev in the Stavropol'skiy Rayon. Its head will extend approximately to Cheboksary, thus limiting the area of its large reservoir at the confluence of the Kama and the Volga (the head of water will back up along the Kama to the mouth of the Vyatka River).

The total head of water of the six Volga dams will be approximately 100 meters, utilizing about 75 percent of the 135-meter drop in the 2,600 kilometers between Kalinin and Stalingrad. The head of water of the Ivan'kovo dam will back up to Kalinin.

The topography of the land bordering on the Volga, especially the low left bank, leads to the flooding of large areas with any considerable head of water. Because of the high degree of land development and the density of the population along the Volga, flooding the area causes great economic damage. The Rybinsk reservoir, created by the Shcherbakov dam, flooded the Mologo-Sheksna interfluvial area which included more than 4,000 square kilometers of important agricultural land. The extent of flooding estimated for the Volga dam at Kamyshevsk proposed in 1932 with a high-water mark of plus 20 meters (i.e., with a head of 24 meters which is approximately equal to the head of the Kuybyshev and Stalingrad developments now under construction) showed that the area flooded would have been approximately 380,000 hectares, including 140,000 hectares of plowed land, 90,000 hectares of meadow and pasture, 85,000 hectares of forest and brush, and 50,000 hectares of unusable land. In addition, 14,000 peasant farms as well as 150,000 town and village inhabitants would have had to be moved from this area.

The effects of raising the high-water level of the old Kamyshevsk dam are shown in the following table (taking 100 as a basis with a high-water level of plus 20 meters):

	20 Meters	High-Water Level	
		25 Meters	30 Meters
Total flooded area	100	165	250
Area of plowed land flooded	100	185	300
No of peasant farms flooded	100	230	390
No of village and town inhabitants to be moved	100	180	300
Value of fixed capital flooded and nonproductive investments connected with flooding	100	170	260

The head of the Shcherbakov dam was fixed so that the reservoir would guarantee necessary depths up the Volga as far as Uglich and downstream as far as Gor'kiy during the entire navigation season and guarantee water for the year-around operation of the Shcherbakov hydroelectric power plant. Prior to the construction of the Shcherbakov development, the construction of a hydraulic project at Yaroslavl was contemplated. However, this would not have guaranteed a sufficient increase in the depth of water down to Gor'kiy and up to Uglich, and the production of electricity would have had to be suspended or greatly reduced during the spring flood. Therefore, the plan for the Yaroslavl development was abandoned in favor of the Shcherbakov construction.

The total capacity of the three hydroelectric power plants at Ivan'kovo, Uglich, and Shcherbakov, and of the fourth, under construction at Gor'kiy, is several times less than that of the projected Kuybyshev power station alone.

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This is due to lower head and water flow at the above places. Taking the flow at Stalingrad as 100, the flow at Shcherbakov will be 13, at Gor'kiy 21, and below the mouth of the Oka 35. More than 50 percent of the flow of the Volga is supplied by the Kama, and the flow at Kuybyshev is 97.

The Kuybyshev GES project is located on the Volga above the Samara Bend, thus avoiding flooding the city of Kuybyshev and the petroleum deposits of the Samara Bend region. The dam will create a head of water about 25 meters high which will extend along the Volga approximately to Cheboksary and up the Kama to the mouth of the Vyatka. The reservoir will cover more than 5,000 square kilometers and will have a useful volume of 19.5 cubic kilometers. The dam will be able to catch the spring flood waters and retain them for use during the entire year. The hydroelectric power plant is to reach full capacity (2 million kilowatts) in 1955. Navigation will be permitted by means of two sets of locks, with standard clearances accepted for the Volga navigation. They have been arranged in two steps, separated by a body of water 3 kilometers long, which will also be used to berth a fleet in winter. For servicing the hydroelectric power plant and the industries gravitating toward it, a port will probably be built on the upper level (see Rechnoy Transport, No 1, 1951, p 17).

The Stalingrad hydraulic project is located somewhat above Stalingrad. Its head will be approximately the same height as that of the Kuybyshev dam and is to extend almost to Balakovo, forming a reservoir of approximately 5,000 square kilometers.

Both the Kuybyshev and Stalingrad dams will aid river navigation. The Volga will become a deep-water route up to Kalinin and will become accessible to larger vessels, thus greatly reducing the cost of transportation. On a number of sections of the river, navigation conditions will be similar to those on lakes, and this will make new technical demands on the Volga fleet.

Below the Kama, the tributaries (Cheremshan, Sok, Samara, Kinel', Belyy, Irgiz, etc.) contribute relatively little water to the Volga. Therefore, most of the irrigation in this area must be done with water from the Volga. Only a small part of the irrigation will be accomplished by gravity flow.

The Kuybyshev hydraulic development is to irrigate one million hectares of land in Kuybyshev Oblast (except for its northern corner), the northern part of Saratov Oblast (as far as the latitude of Saratov), the western part of Chkalov Oblast (the basin of the Samara River), the southwest part of Ul'yanovsk Oblast, and the southern part of Penza Oblast. This creates a vast area, both along the Volga and away from it, mainly to the east along the valleys on the left-bank tributaries of the Volga.

The relief of the left bank of the Volga is favorable for irrigation, and large canals and systems can be built for irrigating large continuous areas with water from the Volga. In the high areas more distant from the Volga, up to 150 meters in places, it is expedient to utilize local streams with the aid of pumps run by electric power from the Kuybyshev GES. Wherever possible gravity-flow irrigation will be employed. Local rivers will be used primarily in Chkalov and Penza oblasts, while water from the Volga will be the main source for irrigation in Kuybyshev and Saratov oblasts.

The Stalingrad Main Canal (flowing by gravity), with a capacity of 400 cubic meters per second, will receive water from the reservoir of the Stalingrad dam and will irrigate about 6 million hectares of land in the northern part of the Caspian Depression; i.e., within the West Kazakhstan and Gur'yev oblasts, between the Volga and the Ural rivers. The canal will originate at the reservoir, somewhat above Stalingrad, and will run from west to east,

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between lakes El'ton and Botkul', toward the Kamysh-Samara group of lakes. An alternate plan would take the canal farther north of the lakes, intersecting the Belyy Uzen' River at Furmanov and reaching the Ural and the Kalmykov rivers. Another alternate plan would take the canal through the region of these lakes, reaching the Ural River somewhat farther south. In any case, a large reservoir, approximately 4,000 square kilometers in area, will be formed in the vicinity of the Kamysh-Samara Lakes.

The irrigation of these large areas in Gur'yev and West Kazakhstan oblasts and their afforestation represent the beginning of the fight against drought in the desert and semidesert regions of the Caspian Depression. The canal will be navigable by large Volga River vessels.

An area of 1.5 million hectares in three regions will be supplied by a number of irrigation systems originating at various points on the Volga, both above and below the Stalingrad dam: (1) the region between the Volga and the Ural rivers, to the north of the Stalingrad Main Canal; (2) the area on the right bank between the Volga and the Ilovlya rivers; and (3) the area within the boundaries of the Volga-Aktyubinsk valley. In some years, the latter valley is flooded from the end of April to the end of June, thus limiting the possibilities of utilizing it for crops. After the construction of the Stalingrad dam, the valley will no longer be flooded but will be irrigated by water from the Volga which will be raised an average of 7-10 meters by pumps.

An area of 5.5 million hectares on the right bank, extending south from Stalingrad toward Groznyy Oblast, is also to be irrigated. This territory includes the Sarpinsk Depression, the black-earth region, and the Nogaysk Steppe. The principal irrigation canal of this system will originate at the Volga below the junction with the Volga-Don Canal and consequently below Stalingrad and the Stalingrad hydraulic development. Volga water will be raised into the canal to a height of about 15-20 meters, and then will flow by gravity. The canal will pass along the line of the Sarpinsk lakes, which will be converted into reservoirs. From the south, the Nogaysk Steppe will be irrigated by water from the Terek River.

The Sarpinsk Canal and the Stalingrad Main Canal, together with the great area they irrigate, constitute an important link in the ring of irrigation improvements in the vicinity of the Caspian Sea (the Samur-Divichi Canal, irrigation of the Kurinsk Depression, the Main Turkmen Canal, etc.). The Stalingrad hydraulic development will also provide for the irrigation of a large area of the northern Caucasus and the lower Don through irrigation of the Sarpinsk Depression and the black-earth region, transferring water from the Kuban through the Nevinnomyssk and the Manych canals and the irrigation of the regions along the Don.

When the Stalingrad hydraulic development is completed Stalingrad will be the center of six radiating waterways: The upper and lower Volga, the gravity-flowing Stalingrad Main Canal (which will be navigable), the Volga-Don Canal, and the Sarpinsk and Yergeninsk canals.

The Stalingrad dam, like the Kuybyshev development, will dominate a vast region which will include a large part of Stalingrad Oblast, portions of West Kazakhstan and Gur'yev oblasts, all of Astrakhan Oblast, and even parts of the Northern Caucasus. Because of the local topography, the average height to which the water will be raised will be less than that of the Kuybyshev hydraulic development. However, the area irrigated (especially that served by pumps) will be considerably greater than that of the Kuybyshev development.

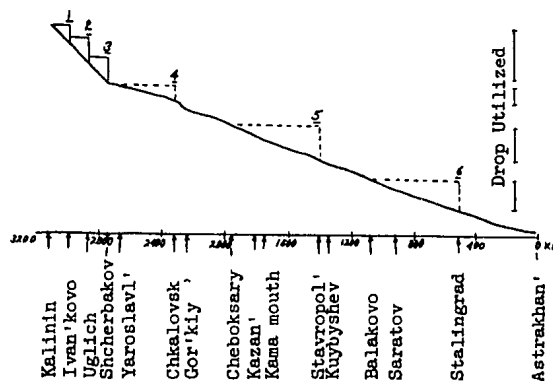
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The irrigation projects of the Stalingrad and Kuybyshev dams will take 30 cubic kilometers of water annually from the Volga, or 12 percent of its flow. Evaporation loss will be greatly increased by the reservoirs. The total area of the Shcherbakov, Gor'kiy, Kuybyshev, Stalingrad, and Kamyshe-Samara reservoirs will cover approximately 21,000 square kilometers, considerably more than the area of Lake Ladoga.

LONGITUDINAL DIAGRAM OF VOLGA PROFILE



Hydroelectric Power Stations From Kalinin to Astrakhan':  
(1) Ivan'kovo, (2) Uglich, (3) Shcherbakov, (4) Gor'kiy,  
(5) Kuybyshev, (6) Stalingrad

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